

HYBRID AUTOMATIC REPEAT REQUEST TIMING IN COMMUNICATIONS

FIELD OF THE INVENTION

[0001] The exemplary and non-limiting embodiments of this invention relate generally to wireless communications networks, and more particularly to transmission control.

BACKGROUND ART

[0002] The following description of background art may include insights, discoveries, understandings or disclosures, or associations together with disclosures not known to the relevant art prior to the present invention but provided by the invention. Some such contributions of the invention may be specifically pointed out below, whereas other such contributions of the invention will be apparent from their context.

[0003] Dynamic frequency scaling (also known as CPU throttling) is a technique whereby the frequency of a micro-processor may be automatically adjusted “on the fly” either to conserve power or to reduce the amount of heat generated by the chip. Dynamic frequency scaling is commonly used in laptops and other mobile devices, where energy comes from a battery and thus is limited. It is also used in quiet computing settings and to decrease energy and cooling costs for lightly loaded machines. Less heat output, in turn, allows the system cooling fans to be throttled down or turned off, reducing noise levels, and further decreasing power consumption. It is also used for reducing heat in insufficiently cooled systems when the temperature reaches a certain threshold. Due to static power consumption and asymptotic execution time the energy consumption of a piece of software shows convex energy behaviour, i.e. there is an optimal CPU frequency at which the energy consumption is minimal. Leakage current has become more and more important as transistor sizes have become smaller and threshold voltage levels lower. Dynamic frequency scaling reduces the number of instructions a processor is able to issue in a given period of time, thus reducing performance.

SUMMARY

[0004] The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is not intended to identify key/critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0005] Various aspects of the invention comprise methods, an apparatus, and a computer program product as defined in the independent claims. Further embodiments of the invention are disclosed in the dependent claims.

[0006] An aspect of the invention relates to a method for transmission control in a communications system, the method comprising defining, in a network apparatus, a hybrid automatic repeat request profile for a user terminal among a plurality of hybrid automatic repeat request profiles available, wherein the hybrid automatic repeat request profile indicates a first time interval between downlink transmission being received in the user terminal and corresponding uplink control information being expected to be transmitted from the user terminal, and a second time interval between the uplink control information being trans-

mitted from the user terminal and corresponding downlink retransmission at earliest being expected to be received in the user terminal.

[0007] A further aspect of the invention relates to a method for transmission control in a communications system, the method comprising defining, in a network apparatus, a hybrid automatic repeat request profile for a user terminal among a plurality of hybrid automatic repeat request profiles available, wherein the hybrid automatic repeat request profile indicates a third time interval between uplink transmission being received in a base station and corresponding downlink information being expected to be transmitted from the base station, and a fourth time interval between the downlink information being transmitted from the base station and corresponding uplink retransmission at earliest being expected to be received in the base station.

[0008] A still further aspect of the invention relates to an apparatus comprising at least one processor; and at least one memory including a computer program code, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to perform any of the method steps.

[0009] A still further aspect of the invention relates to a computer program product comprising program code means configured to perform any of the method steps when the program is run on a computer.

[0010] Although the various aspects, embodiments and features of the invention are recited independently, it should be appreciated that all combinations of the various aspects, embodiments and features of the invention are possible and within the scope of the present invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In the following the invention will be described in greater detail by means of exemplary embodiments with reference to the attached drawings, in which

[0012] FIG. 1 illustrates a timing relationship in synchronous LTE UL;

[0013] FIG. 2 illustrates exemplary HARQ timing profiles with a variable number of HARQ processes;

[0014] FIG. 3 illustrates exemplary HARQ timing profiles with a fixed number of HARQ processes;

[0015] FIG. 4 shows a simplified block diagram illustrating exemplary system architecture;

[0016] FIG. 5 shows a simplified block diagram illustrating exemplary apparatuses;

[0017] FIGS. 6 and 7 show a messaging diagram illustrating an exemplary messaging event according to an embodiment of the invention;

[0018] FIGS. 8 and 9 show a schematic diagram of a flow chart according to an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

[0019] An exemplary embodiment is related to next generation wireless systems such as future evolutions of LTE-advanced, or future generations of completely new wireless systems. An exemplary embodiment is related to HARQ (hybrid automatic repeat request) operation which is used in existing cellular wireless communication system to allow for high spectral efficiency, as HARQ provides protection against packet transmission errors. Such transmission/recep-